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JACKET			
a. Serial No.	f. Foreign Priority	k. Print Claim(s)	p. PTO-1449
b. Applicant(s)	g. Disclaimer	l. Print Fig.	q. PTOL-85b
c. Continuing Data	h. Microfiche Appendix	m. Searched Column	r. Abstract
d. PCT	i. Title	n. PTO-270/328	s. Sheets/Figs
e. Domestic Priority	j. Claims Allowed	o. PTO-892	t. Other

SPECIFICATION

a. Page Missing
b. Text Continuity
c. Holes through Data
d. Other Missing Text
e. Illegible Text
f. Duplicate Text
g. Brief Description
h. Sequence Listing
i. Appendix
j. Amendments
k. Other

CLAIMS

a. Claim(s) Missing
b. Improper Dependency
c. Duplicate Numbers
d. Incorrect Numbering
e. Index Disagrees
f. Punctuation
g. Amendments
h. Bracketing
i. Missing Text
j. Duplicate Text
k. Other

MESSAGE

Data are missing on pages 1, 2, 3 and 4 of specifications (paragraphs 4, 8, 9, 14, 17, 18 and 19). (See attached).
Also, on page 2 of 3 of claim pages dated 3/19/02.
Please provide new pages with complete data.

~~PCT / EP00/07076~~ (German)
~~Mathias Fright~~ Neil Greenblum
703-716-1191
P21932

talked ~~3/11~~ 3/23 Joh. Preta

Thumlugan

Pre A of 3/19/02 (8 pp)
Original spec (5 pp)
Amdt of 9/8/03 (25 pp incl. dwg)

initials Cnm

RESPONSE Claim pages you requested are not the allowed claims. They are in amdt. paper of 9/8/03, which had missing data also.
Supplied following documents: (1) orig. spec, claims, abstract, ~~as~~ requested;
(2) Prelim. amd't of 3/19/02 (missing data in spec. amd't);
(3) amd't. of 9/8/03; (4) 1449 of 5/14/02 (clarified ~~doc.~~ ~~#s~~ just in case). [Amd't of 3/11/03 looks okay.] initials

Please ask for everything you need and for the right things.

-dsf

E-5 (Rev. 10/01/02)

Patent Application:
X-ray anode and Process for its Manufacture

Applicant:
Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung e.V.

Specification

Technical Field

[0001] The invention relates to an x-ray anode and a process for its manufacture. The x-ray anode according to the invention is preferred for use in x-ray units where the highest possible x-radiation is necessary. It is particularly preferred for use with x-ray microscopes in which a high radiation intensity guarantees the highest resolutions.

Prior Art

[0002] In x-ray production, metallic anode material is usually impinged on with electrons. The radiation caused by characteristic electronic transitions exits the apparatus through a window transparent for x-rays. In order to avoid absorption, X-ray production results here at low gas pressures. The transparent window serves to separate the low pressure area from the outside area.

[0003] Metallic x-ray anodes made of e.g., copper or molybdenum, and a beryllium window in a target angle arrangement are known. There is a certain spacing between the anode and the beryllium window here and they are tilted towards one another. If the x-radiation produced is used for x-ray microscope purposes, this solution has the disadvantage of the resolution being only quite small because of the unavoidable ray divergence between the anode and the object to be imaged. Beryllium is also highly toxic and should therefore be avoided as far as possible as a window material.

[0004] As an alternative to beryllium windows as x-ray exit windows for x-ray units, US 5,173,612 suggests using a diamond window a few 10 μm thick. However, since thicker diamond windows are ruled out because of increased absorption by diamond, these thin diamond windows cause considerable mechanical problems. Thin diamond windows can hardly withstand the pressure differential of approximately 10^5 Pa between the low pressure area and the outside area and have to be stabilized by appropriate crosspieces at considerable cost.

[0005] Also known are so-called microfocus sources, where the anode material forms a layer on a beryllium window and where the anode is bombarded by an electron beam as strongly focussed as possible. In the case of these microfocus sources, the anode moves closer to the object in optical imaging and the optical resolution can be increased. The more sharply the electron beam bombarding the anode is focussed on the anode, the better the resolution. Disregarding diffractions, a spot focus on the anode would be ideal. However, with a spot focus the problem arises that the energy generated by the electron bombardment causes the material to melt or evaporate, thus reducing its operating life. A thicker anode must be selected to compensate for the evaporation of anode material. However, a thick anode results in the x-radiation being absorbed by the anode material itself. The use of a thicker beryllium window is ruled out for the same reason. Moreover, this solution has the considerable disadvantage that mechanical problems can occur due to the existing pressure differentials, and the microfocus source can easily burst. However, this is particularly harmful in the case of toxic beryllium, where a rupture of the microfocus source leads to undesirable apparatus down-time because of the safety measures for staff protection then required. For these reasons according to prior art spot focussing is possible only to a limited extent.

Description of the Invention

[0006] The invention is based on the technical problem of producing an x-ray anode that avoids the disadvantages of the prior art as far as possible. The x-ray anode needs to be harmless from a health viewpoint and, in particular, should make it possible to work with a much smaller focus than with the prior art.

[0007] The solution of this technical problem is achieved through the features listed in claim 1. The process-related task of producing such an x-ray anode is solved by the features of claim 16. Advantageous embodiments are provided in the dependent claims.

[0008] According to the invention it was recognized that the problems could be solved by an x-ray anode where the anode material is on a diamond window.

[0009] At first, diamond seems unsuitable as a material for a microfocus source. With an atomic number of Z=6, diamond absorbs x-radiation more than beryllium at Z=4. It would therefore be expected that the diamond windows used would have to be thinner than beryllium

windows, entailing the above-mentioned mechanical problems. Moreover, up until now, only beryllium was considered as a window material, since beryllium is a rollable metal from which it is easy to make beryllium windows. According to the prior art, this window serves as a substrate for a metal anode to be applied.

[0010] However, it has been possible to prove with experiments that these disadvantages could be overcompensated by a diamond substrate. Contrary to expectations, it is possible to work with a much smaller focus with an x-ray anode on a diamond window than it is with an x-ray anode on a beryllium window. The reason for the overcompensation is that diamond is an excellent heat conductor, so the thermal energy produced can be dissipated with particular efficiency through the diamond substrate. The focal spot therefore heats up less and it is possible to increase the focus. This leads, as desired, to greater radiation densities. Conversely, exchanging a diamond window for the beryllium window with the same beam density and operating life renders possible a thinner anode with lower absorption of x-radiation.

[0011] It has been shown that even relatively thick diamond layers can be used advantageously with very thin anodes. In this context, diamond windows are also suitable with thicknesses of between 50μm and 1000μm, or still better between 300 μm and 700μm. With such thicknesses, an efficient removal of heat and a good mechanical stability is guaranteed.

[0012] According to the present invention, a polycrystalline diamond substrate or diamond window can be used, as well as a monocrystal window. A polycrystalline diamond substrate can be produced particularly simply by means of chemical vapor deposition (CVD), e.g., by hot-filament CVD or microwave CVD. This also makes it possible to produce larger diamond substrates at moderate prices. The deposition of the anode material takes place through a different deposition process, e.g., physical vapor deposition (PVD).

[0013] Basically, metals, several layers of metal, or metal alloys can be considered as anode material. The thickness of the anode material should preferably be in the range of between 1μm and 25 μm, even better in the range of between 3 μm and 12 μm, and best of all at 6 μm.

[0014] The layers do not need to feature constant thicknesses. This means that, e.g., in the case of a disk-shaped microfocus source, the disk thickness does not need to be uniform. The disk can have, e.g., a greater thickness at the edges. The thicknesses given above for the layers should therefore be understood to refer to thicknesses in the focal spot.

[0015] In order to ensure that there is always sufficient anode material on the diamond, and that it has not evaporated after a certain number of hours in operation, a temperature sensor can be provided for the x-ray anode according to the invention. A creative possibility here is using the diamond window as a thermistor, i.e., exploiting the temperature dependence of the electrical resistance of the diamond window. After the appropriate calibration, the user has only to set the optimal operating point regarding the desired radiation intensity with a minimal evaporation rate. This makes it easier to avoid thermally-conditioned damage to the x-ray anode according to the invention. Even in the event that part of the anode material has evaporated after a certain number of hours in operation, the diamond window, as an uncommonly thermally stable material, will usually be completely intact. In this case, the remaining anode material can be chemically removed and the diamond window can be recoated in the course of maintenance work. Choosing diamond as a window material thus renders possible a cost-efficient overhaul of the x-ray anode according to the invention, while simultaneously reusing the diamond window.

[0016] In its simplest embodiment, the anode material is found holohedrally on the diamond substrate. Depending on the special features of production or of the planned use for the microfocus source, however, it can be sufficient for only part of the diamond layer to be covered by the anode material. Depending on the adhesion of the anode material to the diamond substrate, it can be sufficient to apply the anode material directly on the diamond layer. However, in the case of poor adhesion, an adhesion-promoting intermediate layer can be advantageous. An intermediate layer can likewise be advantageous when as far as possible monochromatic radiation needs to be emitted from the x-ray anode. In this case, the intermediate layer acts as a radiation filter and/or a monochromator.

[0017] Tests have further shown that, with the same radiation output, temperature-sensitive samples can be better examined with the x-ray anode according to the invention than with the comparison anode with a beryllium window. Due to the excellent thermal conduction of diamond, the temperatures on the side facing the atmospheric area are lower, which makes it possible to place the samples closer to the window. This in turn results in a better optical resolution.

[0018] An exemplary embodiment of the invention is described in greater detail below:

[0019] A polycrystalline diamond layer (1) with a thickness of 250 μm is deposited on an

auxiliary substrate using hot-filament CVD. After removing the auxiliary substrate, a tungsten layer (2) with a thickness of 6 μm is deposited on this diamond layer using physical vapor deposition (PVD). The tungsten layer covers the diamond layer completely. The x-ray source is mounted in the housing (4) of a commercial x-ray microscope by means of a clamp (3), with sealing washers (4) being used to ensure a stable vacuum. The only Fig. 1 shows this microfocus source in installed condition. X-radiation hv is produced by localized bombardment of the x-ray anode with electrons e^-. The maximum achievable radiation density is measured with this x-ray anode. If the diamond layer is replaced with a 500 μm thick beryllium layer under otherwise identical conditions, the radiation density of the x-radiation produced is reduced by a factor of 4. With a diamond layer thickness of likewise 500 μm, the radiation density achievable with the x-ray anode according to the invention would be even better, due to the improved heat dissipation.

Patent Claims

1. X-ray anode, characterized in that the anode material is located on a diamond window.
2. X-ray anode according to claim 1, characterized in that it is a polycrystalline diamond window.
3. X-ray anode according to claim 1, characterized in that the diamond window is a monocrystal.
4. X-ray anode according to at least one of claims 1 through 3, characterized in that the thickness of the diamond window is in the range of 50 μm to 2000 μm.
5. X-ray anode according to claim 4, characterized in that the thickness of the diamond window is in the range of 300 μm to 700 μm.
6. X-ray anode according to at least one of claims 1 through 5, characterized in that the anode material is a metal, an alloy or several layers of metal.
7. X-ray anode according to at least one of claims 1 through 6, characterized in that the anode material thickness is between 1 μm and 25 μm.
8. X-ray anode according to claim 7, characterized in that the anode material thickness is between 3 μm and 12 μm.
9. X-ray anode according to claim 8, characterized in that the anode material thickness is 6 μm.
10. X-ray anode according to at least one of claims 1 through 9, characterized in that the anode material completely covers the window.
11. X-ray anode according to at least one of claims 1 through 9, characterized in that the anode material partially covers the window.
12. X-ray anode according to at least one of claims I through 11, characterized in that an intermediate layer is provided between the x-ray anode and the diamond window.
13. X-ray anode according to at least one of claims 1 through 12, characterized in that the intermediate layer is an adhesion-promoting layer.
14. X-ray anode according to at least one of claims 1 through 13, characterized in that the intermediate layer is a radiation filter.
15. X-ray anode according to at least one of claims 1 through 14, characterized in that a temperature sensor is provided.

16. X-ray anode according to claim 15, characterized in that the diamond window is provided as a temperature sensor.
17. Process for manufacturing an x-ray anode, particularly for manufacturing an x-ray anode according to one of claims 1 through 16, characterized in that an auxiliary layer is coated with a diamond layer by means of chemical vapor deposition (CVD), and a metallic layer is deposited on this diamond layer.
18. Process according to claim 17, characterized in that the coating of the auxiliary substrate is carried out by means of hot-filament CVD or microwave CVD.
19. Process according to at least one of claims 17 through 18, characterized in that a diamond layer with a thickness of 50 μm to 1000 μm is deposited.
20. Process according to claim 19, characterized in that a diamond layer with a thickness of 300 μm to 700 μm is deposited.
21. Use of an x-ray anode according to at least one of claims 1 through 16 for x-ray units.
22. Use of an x-ray anode according to at least one of claims 1 through 16 for x-ray microscopes.

Abstract

The invention relates to an x-ray anode and a process for its manufacture. The x-ray anode is characterized in that the anode material is embodied as a layer on a diamond window. The x-ray anode is preferably used with x-ray units which require as selective as possible x-radiation production to achieve as high as possible radiation intensity. Use in x-ray microscopes in which a high radiation intensity guarantees the highest resolutions is particularly preferred.

P21932.A01

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants :	Matthias FRYDA et al.	)	Applications Branch
Appln. No. :	10/030,133	)	
Filed :	January 25, 2002	)	
For :	X-RAY ANODE AND PROCESS FOR ITS MANUFACTURE		

PRELIMINARY AMENDMENT AND COVER LETTER SUBMITTING AMENDED PAGES OF APPLICATION

Commissioner of Patents and Trademarks
Washington, D.C. 20231

Sir:

A copy of the International Preliminary Examination Report - Form PCT/IPEA/409 (hereinafter "Report"), was submitted to the Examiner on January 25, 2002. Applicants note that this Report was drawn on pages of description 1 - 7 and 1 sheet of drawings as originally filed, replacement claims 2 - 16 as filed September 5, 2001, and replacement claim 1 as filed November 13, 2001, and includes as an Annex replacement claims 1 - 16 (in German) submitted September 5, 2001 and replacement claim 1 (in German) submitted November 13, 2001. For the Examiner's convenience, an English translation of the Annex is submitted herewith, in which each sheet is identified on the bottom of the page as "MODIFIED SHEET" along with the submission date of the specific sheet.

Based upon the submission of the modified sheets of claims, Applicants respectfully request examination on the merits of the application containing pages of description 1 - 7 and 1 sheet of drawings as originally submitted and replacement claims 2 - 16 submitted September 5, 2001 and replacement claim 1 submitted November 13, 2001 (in place of originally filed claims 1 - 22).

Additionally, prior to the examination of the above-identified application including replacement claims 1 - 16, amendment of specification and claims as follows:

IN THE SPECIFICATION

Please amend the paragraphs as follows (Marked-up copies of the amended paragraphs are attached as an Appendix):

Please replace paragraph [0002] with the following amended paragraph:

[0002] In x-ray production, metallic anode material is usually irradiated with electrons. The radiation caused by characteristic electronic transitions exits the apparatus through a window transparent for x-rays. In order to avoid absorption, X-ray production results here at low gas pressures. The transparent window serves to separate the low pressure area from the outside area.

Please replace paragraph [0010] with the following amended paragraph:

[0010] However, it has been possible to prove with experiments that these disadvantages could be overcompensated by a diamond substrate. Contrary to expectations, it is possible to work with a much smaller focus with an x-ray anode on a diamond window than it is with

an x-ray anode on a beryllium window. The reason for the overcompensation is that diamond is an excellent heat conductor, so the thermal energy produced can be dissipated with particular efficiency through the diamond substrate. The focal spot therefore heats up less and it is possible to decrease the focus diameter. This leads, as desired, to greater radiation densities. Conversely, exchanging a diamond window for the beryllium window with the same beam density and operating life renders possible a thinner anode with lower absorption of x-radiation.

IN THE CLAIMS

Please amend the claims as follows (Marked-up copies of the amended claims are attached as an Appendix):

4. (Amended) X-ray anode according to claim 1, characterized in that the anode material is a metal, an alloy or several layers of metal.

5. (Amended) X-ray anode according to claim 1, characterized in that the anode material thickness is between 1 μm and 25 μm.

8. (Amended) X-ray anode according to claim 1, characterized in that the anode material completely covers the window.

9. (Amended) X-ray anode according to claim 1, characterized in that the anode material partially covers the window.

10. (Amended) X-ray anode according to claim 1, characterized in that an intermediate layer is provided between the x-ray anode and the diamond window.

11. (Amended) X-ray anode according to claim 1, characterized in that the intermediate layer is an adhesion-promoting layer.

12. (Amended) X-ray anode according to claim 1, characterized in that the intermediate layer is a radiation filter.

13. (Amended) X-ray anode according to claim 1, characterized in that a temperature sensor is provided.

15. (Amended) Use of an x-ray anode according to claim 1 for x-ray microscopes.

16. (Amended) Use of an x-ray anode according to claim 1 for x-ray units.

REMARKS

Entry of the foregoing replacement sheets upon which the International Preliminary Examination Report is based and amendment of the specification and claims are respectfully requested.. Applicants note that the instant amendments have been made to generally improve the form of the application and remove multiply dependent claims prior to the calculation of fees.

Should there be any questions, the Examiner is invited to contact the undersigned at the below listed number.

Respectfully submitted,
Matthias FRYDA et al.

4/3,017

Neil F. Greenblum
Reg. No. 28,394

March 19, 2002
GREENBLUM & BERNSTEIN, P.L.C.
1941 Roland Clarke Place
Reston, VA 20191
(703) 716-1191

P21932.A01

APPENDIX

Marked-Up Copies of the Amended Paragraphs:

Please replace paragraph [0002] with the following amended paragraph:

[0002] In x-ray production, metallic anode material is usually [impinged on] <u>irradiated</u> with electrons. The radiation caused by characteristic electronic transitions exits the apparatus through a window transparent for x-rays. In order to avoid absorption, X-ray production results here at low gas pressures. The transparent window serves to separate the low pressure area from the outside area.

Please replace paragraph [0010] with the following amended paragraph:

[0010] However, it has been possible to prove with experiments that these disadvantages could be overcompensated by a diamond substrate. Contrary to expectations, it is possible to work with a much smaller focus with an x-ray anode on a diamond window than it is with an x-ray anode on a beryllium window. The reason for the overcompensation is that diamond is an excellent heat conductor, so the thermal energy produced can be dissipated with particular efficiency through the diamond substrate. The focal spot therefore heats up less and it is possible to [increase the focus] <u>decrease the focus diameter</u>. This leads, as desired, to greater radiation densities. Conversely, exchanging a diamond window for the beryllium window with the same beam density and operating life renders possible a thinner anode with lower absorption of x-radiation.

Marked-Up Copies of the Amended Claims:

4. (Amended) X-ray anode according to [at least one of claims 1 through 3] claim 1, characterized in that the anode material is a metal, an alloy or several layers of metal.

5. (Amended) X-ray anode according to [at least one of claims 1 through 4] claim 1, characterized in that the anode material thickness is between 1 μm and 25 μm.

8. (Amended) X-ray anode according to [at least one of claims 1 through 7] claim 1, characterized in that the anode material completely covers the window.

9. (Amended) X-ray anode according to [at least one of claims 1 through 8] claim 1, characterized in that the anode material partially covers the window.

10. (Amended) X-ray anode according to [at least one of claims 1 through 9] claim 1, characterized in that an intermediate layer is provided between the x-ray anode and the diamond window.

11. (Amended) X-ray anode according to [at least one of claims 1 through 10] claim 1, characterized in that the intermediate layer is an adhesion-promoting layer.

12. (Amended) X-ray anode according to [at least one of claims 1 through 11] claim 1, characterized in that the intermediate layer is a radiation filter.

13. (Amended) X-ray anode according to [at least one of claims 1 through 12] claim 1, characterized in that a temperature sensor is provided.

15. (Amended) Use of an x-ray anode according to [at least one of claims 1 through 14] claim 1 for x-ray microscopes.

16. (Amended) Use of an x-ray anode according to [at least one of claims 1 through 14] claim 1 for x-ray units.

New Patent Claim 1

1. X-ray anode for microfocus sources in which the anode material is located on a diamond window, characterized in that the thickness of the diamond window is in the range of 300 μm to 2000 μm.

This is followed by the currently valid patent claims 2 through 16.

New Patent Claims

1. X-ray anode, characterized in that the anode material is located on a diamond window, characterized in that the thickness of the diamond window is in the range of 300 μm to 700 μm or in the range of 700 μm to 2000 μm.
2. X-ray anode according to claim 1, characterized in that it is a polychrystalline diamond window.
3. X-ray anode according to claim 1, characterized in that the diamond window is a monocrystal.
4. X-ray anode according to at least one of claims 1 through 3, characterized in that the anode material is a metal, an alloy or several layers of metal.
5. X-ray anode according to at least one of claims 1 through 4, characterized in that the anode material thickness is between 1 μm and 25 μm.
6. X-ray anode according to claim 5, characterized in that the anode material thickness is between 3 μm and 12 μm.
7. X-ray anode according to claim 6, characterized in that the anode material thickness is 6 μm.
8. X-ray anode according to at least one of claims 1 through 7, characterized in that the anode material completely covers the window.
9. X-ray anode according to at least one of claims 1 through 8, characterized in that the anode material partially covers the window.
10. X-ray anode according to at least one of claims 1 through 9, characterized in that an intermediate layer is provided between the x-ray anode and the diamond window.
11. X-ray anode according to at least one of claims 1 through 10, characterized in that the intermediate layer is an adhesion-promoting layer.
12. X-ray anode according to at least one of claims 1 through 11, characterized in that the intermediate layer is a radiation filter.
13. X-ray anode according to at least one of claims 1 through 12, characterized in that a temperature sensor is provided.
14. X-ray anode according to claim 13, characterized in that the diamond window is provided

as a temperature sensor.

15. Use of an x-ray anode according to at least one of claims 1 through 14 for x-ray microscopes.

16. Use of an x-ray anode according to at least one of claims 1 through 14 for x-ray units.

P21932.A07

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants	:	Matthias FRYDA et al.	Group Art Unit: 2882
Appln. No.	:	10/030,133	Examiner: I. Kiknadze
Filed	:	January 25, 2002	
For	:	X-RAY ANODE AND PROCESS FOR ITS MANUFACTURE	

AMENDMENT UNDER 37 C.F.R. 1.111

Commissioner For Patents
PO Box 1450,
Alexandria, Virginia 23313-1450

Sir:

Responsive to the Official Action of June 10, 2003, reconsideration and withdrawal of the rejections made therein are respectfully requested, in view of the following amendments and remarks.

Inasmuch as the Official Action sets a three-month shortened statutory period which expires September 10, 2003, this Amendment is being timely filed and no extension of time is believed necessary. However, if an extension is deemed by the Patent and Trademark Office to be necessary, the same is hereby requested and the Patent and Trademark Office is hereby authorized to charge any necessary fees in connection therewith or any fees necessary to preserve the pendency of this application to deposit account No. 19-0089.

P21932.A07

IN THE SPECIFICATION

Please replace paragraph [0019] of the specification with the following:

[0019] A polycrystalline diamond layer 1 with a thickness of 250 μm is deposited on an auxiliary substrate using hot-filament CVD. After removing the auxiliary substrate, a tungsten layer 2 with a thickness of 6 μm is deposited on this diamond layer using physical vapor deposition (PVD). The tungsten layer covers the diamond layer completely. The x-ray source is mounted in the housing ~~(4)~~ 4 of a commercial x-ray microscope by a clamp 3, with sealing washers ~~14~~ 5 being used to ensure a stable vacuum. The Figure shows this microfocus source in installed condition. X-radiation hν is produced by localized bombardment of the x-ray anode with electrons e^-. The maximum achievable radiation density is measured with this x-ray anode. If the diamond layer is replaced with a 500 μm thick beryllium layer under otherwise identical conditions, the radiation density of the x-radiation produced is reduced by a factor of 4. With a diamond layer thickness of likewise 500 μm, the radiation density achievable with the x-ray anode according to the invention would be even better, due to the improved heat dissipation.

P21932.A07

IN THE DRAWINGS

Please replace the drawing sheet illustrating Fig. 1 with the "Replacement Drawing Sheet" attached to the end of this Amendment:

In the Replacement Drawing Sheet showing Fig. 1, reference number 5 has replaced reference number 4. Applicant submits that no new matter has been added to the drawings.

P21932.A07

IN THE CLAIMS

Please amend claims 26 and 32 as follows and add new claims 42-44 as follows:

Claims 1-16 (Canceled).

17. (Previously presented) An x-ray anode for microfocus sources comprising:

a diamond window having a thickness in a range of 300 μm to 2000 μm;

an anode material being located on said diamond window.

18. (Previously presented) The x-ray anode in accordance with claim 17, wherein said diamond window comprises a polychrystalline diamond window.

19. (Previously presented) The x-ray anode in accordance with claim 17, wherein said diamond window is a monocrystal.

20. (Previously presented) The x-ray anode in accordance with claim 17, wherein said anode material comprises at least one of a metal, an alloy, and a plurality of layers of metal.

21. (Previously presented) The x-ray anode in accordance with claim 17, wherein said

anode material has a thickness between 1 μm and 25 μm.

22. (Previously presented) The x-ray anode in accordance with claim 17, wherein said anode material has a thickness between 3 μm and 12 μm.

23. (Previously presented) The x-ray anode in accordance with claim 17, wherein said anode material has a thickness of 6 μm.

24. (Previously presented) The x-ray anode in accordance with claim 17, wherein said anode material at least partially covers said diamond window.

25. (Previously presented) The x-ray anode in accordance with claim 17, wherein said anode material completely covers a surface of said diamond window.

26. (Currently Amended) The x-ray anode in accordance with claim 17, wherein said anode material only partially covers a surface of said <u>diamond</u> window.

27. (Previously presented) The x-ray anode in accordance with claim 17, further comprising an intermediate layer positioned between said anode material and said diamond

window.

28. (Previously presented) The x-ray anode in accordance with claim 27, wherein said intermediate layer comprises an adhesion-promoting layer.

29. (Previously presented) The x-ray anode in accordance with claim 27, wherein said intermediate layer comprises a radiation filter.

30. (Previously presented) The x-ray anode in accordance with claim 17, further comprising a temperature sensor.

31. (Previously presented) The x-ray anode in accordance with claim 17, wherein said diamond window is structured and arranged as a temperature sensor.

32. (Currently Amended) The x-ray anode in accordance with claim 17, wherein said x-ray anode is structured and arranged for use in an x-ray ~~microscopes~~ microscope.

33. (Previously presented) The x-ray anode in accordance with claim 17, wherein said x-ray anode is structured and arranged for use in an x-ray unit.

34. (Previously presented) The x-ray anode in accordance with claim 17, wherein said anode material comprises tungsten.

35. (Previously presented) The x-ray anode in accordance with claim 17, wherein said anode material is located on said diamond window by physical vapor deposition.

36. (Previously presented) The x-ray anode in accordance with claim 17, wherein said diamond layer is formed on an auxiliary substrate by chemical vapor deposition.

37. (Previously presented) An x-ray anode formed by a process comprising:

locating an anode material on a diamond window having a thickness in a range of 300 μm to 2000 μm.

38. (Previously presented) The x-ray anode in accordance with claim 37, wherein said anode material is located on said diamond window by physical vapor deposition.

39. (Previously presented) The x-ray anode in accordance with claim 37, wherein, before the anode material is located on said diamond window, said process further comprises:

forming said diamond window by depositing a polycrystalline diamond layer onto an

34. (Previously presented) The x-ray anode in accordance with claim 17, wherein said anode material comprises tungsten.

35. (Previously presented) The x-ray anode in accordance with claim 17, wherein said anode material is located on said diamond window by physical vapor deposition.

36. (Previously presented) The x-ray anode in accordance with claim 17, wherein said diamond layer is formed on an auxiliary substrate by chemical vapor deposition.

37. (Previously presented) An x-ray anode formed by a process comprising:

locating an anode material on a diamond window having a thickness in a range of 300 μm to 2000 μm.

38. (Previously presented) The x-ray anode in accordance with claim 37, wherein said anode material is located on said diamond window by physical vapor deposition.

39. (Previously presented) The x-ray anode in accordance with claim 37, wherein, before the anode material is located on said diamond window, said process further comprises:

forming said diamond window by depositing a polycrystalline diamond layer onto an

auxiliary substrate; and

removing the auxiliary substrate from the diamond window.

40. (Previously presented) The x-ray anode in accordance with claim 39, wherein said polycrystalline diamond layer is deposited on said auxiliary substrate by chemical vapor deposition.

41. (Previously presented) The x-ray anode in accordance with claim 37, wherein said anode layer at least partially covers a surface of said diamond window.

42. (New) A method of making an x-ray anode, the method comprising:

forming a diamond window with a thickness of between 300 μm to 2000 μm, wherein the diamond window includes an inner surface and an outer surface; and

applying an anode material onto at least a portion of the inner surface.

43. (New) The method of claim 42, wherein, before the applying, the method further comprises applying an intermediate layer onto said diamond window.

44. (New) The method of claim 43, wherein the intermediate layer is an adhesion-

promoting intermediate layer.

REMARKS

Summary of the Amendment

Upon entry of the above amendment, the specification, drawings, and claims 26 and 32 will have been amended. Additionally, claims 42-44 will have been added. Accordingly, claims 17-44 will be pending, with claims 17, 37 and 42 being in independent form.

Summary of the Official Action

In the Office action, the Examiner rejected claims 17 and 20-41 over the applied art of record. On the other hand, the Examiner failed to indicate the status of claims 18 and 19, i.e., these claims were not rejected, nor indicated to contain allowable subject matter. By the present amendment and remarks, Applicant submits that the rejections have been overcome, and respectfully requests reconsideration of the outstanding Office Action and allowance of the present application.

The Examiner cannot properly make the next action Final

Inasmuch as the Examiner has apparently failed, in the instant Official action, to consider the merits of at least claims 18 and 19, Applicant submits that the next action cannot be made final. Accordingly, Applicant respectfully requests that the Examiner carefully consider and treat the merits of all pending claims in the next Official action.

Interview of August 26, 2003

Applicant appreciates the courtesy extended by Examiner Irakli Kiknadze in the interview of August 26, 2003. In that interview, Applicant's representative discussed, among other things, amending Fig.1 to show that the sealing washer is represented with reference number 5 and that the specification would be amended consistent with this change.

Applicant's representative also pointed out that the pending claims recite a diamond window whose thickness is in the range of 300 μm to 2000 μm, i.e., 0.3 mm to 2 mm. On the other hand, the diamond window of IMAI is disclosed as being a maximum of 0.03 mm. Specifically, IMAI discloses at col. 4, line 25 (and col. 5, lines 58-59) that diamond layer 1 can have a thickness of up to 10 μm, i.e., 0.01 mm. Moreover, col. 7, lines 30-32 discloses that the diamond reinforcing layer/members 2 can have a thickness (or height) of up to 20 μm, i.e., 0.02 mm. Thus, both diamond thickness are disclosed as being no greater than 30 μm, i.e., 0.03 mm.

Next, it was explained that while Applicant does not dispute that SAHORES discloses a window 3 and/or shell 4 whose thickness is disclosed as being in the range of 1 and 2 mm, it is clear that SAHORES never suggests that a diamond material would function properly in this thickness range. It was specifically pointed out that SAHORES merely discloses a beryllium window 3 (see col. 4, lines 32-33). Moreover, the language of col. 4, lines 9-11 suggesting that the shell 4 "may be made out of any material which is transparent to X-ray

radiation" cannot properly be interpreted to encompass a diamond material because a diamond material in the recited thickness range would have been ruled out due to increased absorption. Indeed, this is clearly explained in paragraph [0004] of Applicant's specification.

Next, it was explained that Applicant has discovered that a diamond window can be made significantly thicker than that of the prior art. This is explained on paragraphs [0010] and [0011] of Applicant's specification.

Finally, Applicant pointed out that the other applied documents similarly lack a diamond window with the recited thickness.

In response, the Examiner agreed to reconsider the rejections if such arguments and explanations were presented in a response.

Traversal of Rejections Under 35 U.S.C. § 103(a)

Applicant traverses the rejection of claims 17, 20-26, 32, 33 and 35-41 under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 4,159,437 to SAHORES in view of U.S. Patent No. 5,173,612 to IMAI et al.

The Examiner acknowledged that SAHORES lacks a diamond window with a thickness in the range of 300 μm to 2000 μm. However, the Examiner explains that IMAI discloses a diamond window. Accordingly, the Examiner concluded that it would have been obvious to use a window made of diamond as taught by IMAI on the device of SAHORES.

In support of this conclusion, the Examiner explains that such a combination would achieve "high transparency for X-rays for the X-ray window with high flatness, and high strength." The Examiner also suggests that the use of diamond is merely an obvious matter of selecting a known material.

Applicant also traverses the rejection of claims 27-29 under 35 U.S.C. § 103(a) as being unpatentable over SAHORES in view of IMAI and further in view of U.S. Patent No. 4,622,688 to DIEMER et al.

Applicant additionally traverses the rejection of claims 30 and 31 under 35 U.S.C. § 103(a) as being unpatentable over SAHORES in view of IMAI and further in view of U.S. Patent No. 5,809,106 to KITADE et al.

Applicant additionally also traverses the rejection of claim 34 under 35 U.S.C. § 103(a) as being unpatentable over SAHORES in view of IMAI and further in view of U.S. Patent No. 6,241,651 to SMITH et al.

The Examiner additionally acknowledged that SAHORES/IMAI lacks an intermediate layer, a temperature sensor, and an anode material comprising tungsten. However, the Examiner explains that DIEMER discloses the use of an intermediate layer, that KITADE discloses a temperature sensor, and that SMITH discloses a tungsten anode material. Accordingly, the Examiner concluded that it would have been obvious to modify the device disclosed in SAHORES/IMAI in view of the teachings of DIEMER, KITADE and SMITH.

Applicant respectfully traverses each of these rejections and the Examiner's assertions.

Applicant respectfully submits that no proper combination of these documents discloses or suggests, inter alia, an x-ray anode for microfocus sources comprising *a diamond window having a thickness in a range of 300 μm to 2000 μm*, and *an anode material being located on said diamond window*, as recited in independent claim 17, and inter alia, an x-ray anode formed by a process comprising *locating an anode material on a diamond window having a thickness in a range of 300 μm to 2000 μm*, as recited in independent claim 37.

As discussed in the Interview, SAHORES clearly lacks any disclosure or suggestion with regard to a diamond window whose thickness is in the range of 300 μm to 2000 μm, i.e., 0.3 mm to 2 mm. To the contrary, SAHORES merely discloses a truncated cone window 3 and/or shell 4 whose thickness can be in the range of 1 and 2 mm. Although, this document indicates that the shell 4 "may be made out of any material which is transparent to X-ray radiation" (see 4, lines 9-11), there is no suggestion whatsoever of using diamond. Moreover, there is no teaching or suggestion of modifying the geometric arrangement of the window, i.e., from a truncated cone to a flat window with reinforcements, or vice versa. Nor can such language properly be interpreted to encompass a diamond material since a diamond material in the recited thickness range would have been ruled out prior to the instant invention because of its increased absorption. This is clearly pointed out in paragraph [0004]

of the instant specification. There it states that thick diamond windows have been ruled out in the prior art because of, e.g., increased absorption.

Applicant emphasizes that SAHORES never suggests that a diamond material would function properly in this thickness range and merely discloses a device whose disadvantages have been recognized in the instant specification. Moreover, it should be apparent to the Examiner that SAHORES discloses a beryllium window 3 (see col. 4, lines 32-33). On the other hand, Applicant has explained on paragraph [0003] of the instant specification that such a material is disadvantageous and that it "should be avoided as far as a window material."

IMAI similarly lacks any disclosure to a diamond window whose thickness is in the range of 300 μm to 2000 μm, i.e., 0.3 mm to 2 mm. To the contrary, the diamond window of IMAI is disclosed as being a maximum of 0.03 mm. As the Examiner must recognize, IMAI discloses at col. 4, line 25 (and col. 5, lines 58-59) that diamond layer 1 can have a thickness of up to 10 μm, i.e., 0.01 mm. Moreover, col. 7, lines 30-32 discloses that the diamond reinforcing layer/members 2 can have a thickness (or height) of up to 20 μm, i.e., 0.02 mm. Thus, both diamond thickness are disclosed as being no greater than 30 μm, i.e., 0.03 mm. A value of 0.03 mm is clearly well outside the recited thickness range of 300 μm to 2000 μm, i.e., 0.3 mm to 2 mm.

Nor does IMAI correct the deficiencies of SAHORES. As the Examiner will note,

the window 3 of SAHORES is a relatively thick truncated cone of beryllium, whereas IMAI discloses a relatively thin flat diamond window which "excels in the flatness" (see col. 8, lines 9-10). Clearly, one of ordinary skill in the art would not be motivated to substitute the thin flat diamond window of IMAI with the much thicker truncated cone of SAHORES. At the very least, such a modification would clearly not produce a flat diamond window which "excels in the flatness", and thus would not operate in the manner intended by IMAI. To the same extent, the art of record provides no motivation or rational to substitute the truncated cone of SAHORES with a flat diamond window of IMAI, as suggested by the Examiner. Nor do either of these documents suggest that diamond and beryllium are inter-changeable in their specific arrangements. Therefore, Applicant submits that the asserted combination of documents must be the result of impermissible hindsight based on Applicant's disclosure.

Applicant further submits that the documents themselves teach away from the asserted combination or modification. For example, col. 2, lines 31-33 of IMAI makes clear that a thick diamond film is not desirable because of its increased absorption, even though it would have improved mechanical strength. Moreover, SAHORES fails to even mention diamond as an optional material for the window.

Indeed, the Examiner's motivation statement is revealing in its failure to point to any disclosure in the applied art to support such a modification. In the Office Action, the Examiner explains that it would have been obvious to use a window made of diamond as

taught by IMAI on the device of SAHORES and that such a combination would achieve "high transparency for X-rays for the X-ray window with high flatness, and high strength." However, what the Examiner fails to consider is that IMAI achieves this high transparency with a *flat* diamond window which is in the form of a film that is reinforced with crosspieces (see col. 4, lines 24-33) and whose a maximum thickness is 0.03 mm, not with *a truncated cone* that is 1 to 2 mm thick, as disclosed by SAHORES. Moreover, the Examiner has never explained what would motivate one of ordinary skill in the art to replace a truncated cone of beryllium with a flat disk of diamond which is at least thirty-three times thinner. Nor has the Examiner provided any valid reason or motivation for replacing a truncated cone of beryllium with a thickness of between 1 and 2 mm with a flat disk of diamond having a thickness of 0.03 mm.

Accordingly, Applicant submits that even if SAHORES and IMAI were properly combined, which Applicant submits they cannot be, they would nevertheless lack features which are recited in at least independent claims 17 and 37. Moreover, each of these documents fails to disclose or suggest the requisite motivation or rationale for combining these documents in the manner asserted by the Examiner. Finally, Applicant submits that IMAI fails to cure the deficiencies lacking in SAHORES, and vice versa.

With regard to DIEMER, KITADE and SMITH, Applicant notes that these documents similarly lack any disclosure or suggestion with regard to a diamond window, much less, an

x-ray anode for microfocus sources comprising *a diamond window having a thickness in a range of 300 μm to 2000 μm*, and *an anode material being located on said diamond window*, and/or an x-ray anode formed by a process comprising *locating an anode material on a diamond window having a thickness in a range of 300 μm to 2000 μm*. These documents also fail to suggest the inter-changeability of diamond and beryllium as the window material.

Accordingly, Applicant also submits that even if these documents were properly combined, which Applicant submits they cannot be, they would nevertheless lack features which are recited in at least independent claims 17 and 37. Moreover, each of IMAI, DIEMER, KITADE, and SMITH fails to disclose or suggest the requisite motivation or rationale for combining these documents in the manner asserted by the Examiner. Finally, Applicant submits that IMAI, DIEMER, KITADE and SMITH fails to cure the deficiencies lacking in SAHORES, and vice versa.

Applicant reminds the Examiner of the guidelines identified in M.P.E.P section 2141 which state that "[i]n determining the propriety of the Patent Office case for obviousness in the first instance, it is necessary to ascertain whether or not the reference teachings would appear to be sufficient for one of ordinary skill in the relevant art having the reference before him to make the proposed substitution, combination, or other modification." *In re Linter*, 458 F.2d 1013, 1016, 173 USPQ 560, 562 (CCPA 1972).

As this section clearly indicates, "[o]bviousness can only be established by combining

or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988); *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992)."

Moreover, it has been legally established that "[t]he mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination. *In re Mills*, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990) .... Although a prior art device "may be capable of being modified to run the way the apparatus is claimed, there must be a suggestion or motivation in the reference to do so." 916 F.2d at 682, 16 USPQ2d at 1432.). See also *In re Fritch*, 972 F.2d 1260, 23 USPQ2d 1780 (Fed. Cir. 1992) (flexible landscape edging device which is conformable to a ground surface of varying slope not suggested by combination of prior art references).

Additionally, it has been held that "[a] statement that modifications of the prior art to meet the claimed invention would have been " 'well within the ordinary skill of the art at the time the claimed invention was made' " because the references relied upon teach that all aspects of the claimed invention were individually known in the art is not sufficient to establish a prima facie case of obviousness without some objective reason to combine the teachings of the references. *Ex parte Levengood*, 28 USPQ2d 1300 (Bd. Pat. App. & Inter.

or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988); *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992)."

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1993)."

Thus, Applicant submits that there is no motivation or rationale disclosed or suggested in the art to modify either document in view of the other in the manner asserted by the Examiner, i.e., to replace a thick truncated cone of beryllium window with a thin reinforced film of diamond. Nor does the Examiner's opinion provide a proper basis for making such a modification or combination, in the manner suggested by the Examiner. Therefore, Applicant submits that the invention as recited in at least independent claims 17 and 37 is not rendered obvious by any reasonable inspection of the disclosures of the applied prior art.

Finally, Applicant submits that claims 20-36 and 38-41 are allowable at least for the reason that these claims depend from an allowable base claim and because these claims recite additional features that further define the present invention. In particular, Applicant submits that no proper combination of the above-noted documents discloses or suggests: that said anode material comprises at least one of a metal, an alloy, and a plurality of layers of metal as recited in claim 20; that said anode material has a thickness between 1 μm and 25 μm as recited in claim 21; that said anode material has a thickness between 3 μm and 12 μm as recited in claim 22; that said anode material has a thickness of 6 μm as recited in claim 23; that said anode material at least partially covers said diamond window as recited in claim 24; that said anode material completely covers a surface of said diamond window as recited in claim 25; that said anode material only partially covers a surface of said diamond window

as recited in claim 26; that the x-ray anode further comprises an intermediate layer positioned between said anode material and said diamond window as recited in claim 27; that said intermediate layer comprises an adhesion-promoting layer as recited in claim 28; that said intermediate layer comprises a radiation filter as recited in claim 29; that the x-ray anode further comprises a temperature sensor as recited in claim 30; that said diamond window is structured and arranged as a temperature sensor as recited in claim 31; that said x-ray anode is structured and arranged for use in an x-ray microscope as recited in claim 32; that said x-ray anode is structured and arranged for use in an x-ray unit as recited in claim 33; that said anode material comprises tungsten as recited in claim 34; that said anode material is located on said diamond window by physical vapor deposition as recited in claim 35; that said diamond layer is formed on an auxiliary substrate by chemical vapor deposition as recited in claim 36; that said anode material is located on said diamond window by physical vapor deposition as recited in claim 38; that before the anode material is located on said diamond window, said process further comprises forming said diamond window by depositing a polycrystalline diamond layer onto an auxiliary substrate and removing the auxiliary substrate from the diamond window as recited in claim 39; that said polycrystalline diamond layer is deposited on said auxiliary substrate by chemical vapor deposition as recited in claim 40; and that said anode layer at least partially covers a surface of said diamond window as recited in claim 41.

Accordingly, Applicant requests that the Examiner reconsider and withdraw the rejection of the above-noted claims under 35 U.S.C. § 103(a) and indicate that these claims are allowable.

New Claims are also Allowable

Applicant submits that the new claims are also allowable over the applied art of record. In particular, Applicant submits that claims 42-44 recite a combination of features which are not disclosed or suggested by the Applied art of record.

Accordingly, Applicant respectfully requests consideration of these claims and further request that the above-noted claims be indicated as allowable.

CONCLUSION

Applicant respectfully submits that each and every pending claim of the present invention meets the requirements for patentability under 35 U.S.C. § § 112, 102 and 103 and respectfully requests the Examiner to indicate allowance of each and every pending claim of the present invention.

In view of the foregoing, it is submitted that none of the references of record, either taken alone or in any proper combination thereof, anticipate or render obvious the Applicant's invention, as recited in each of the pending claims. The applied references of

record have been discussed and distinguished, while significant claimed features of the present invention have been pointed out.

Further, any amendments to the claims which have been made in this response and which have not been specifically noted to overcome a rejection based upon the prior art, should be considered to have been made for a purpose unrelated to patentability, and no estoppel should be deemed to attach thereto.

The Commissioner is hereby authorized to charge any fees necessary for consideration of this amendment to deposit account No. 19-0089.

Should there be any questions, the Examiner is invited to contact the undersigned at the below listed number.

Respectfully submitted,
Matthias FRYDA et al.

Neil F. Greenblum
Reg. No. 28,394

September 4, 2003

GREENBLUM & BERNSTEIN, P.L.C.
1950 Roland Clarke Place
Reston, VA 20191
(703) 716-1191

Replacement Sheet

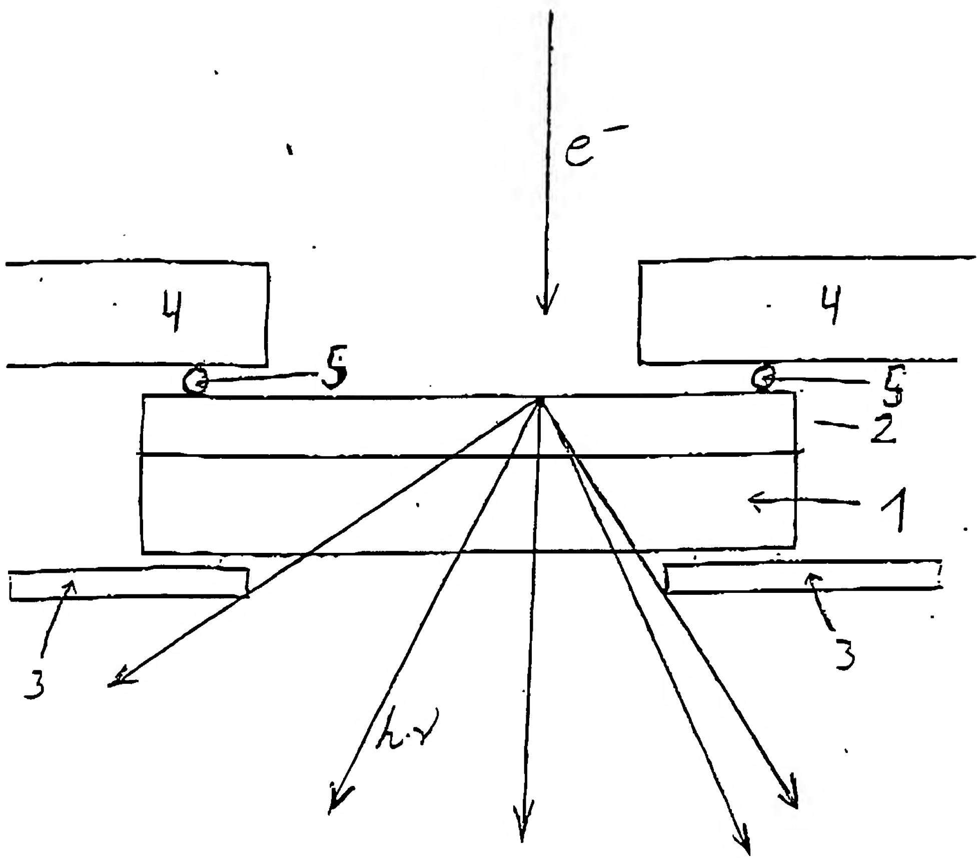

Fig. 1

P21932 Po

Sheet 1 of 1

Form PTO-1449 U. S. Department of Commerce Patent and Trademark Office	Atty. Docket No. P21932	Serial No. 10/030,133
INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Use several sheets if necessary)	Applicant M. FRYDA et al	
	Filing Date January 25, 2002	Group 2882

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U.S. PATENT DOCUMENTS

EXAMINER INITIAL	DOCUMENT NUMBER	DATE	NAME	CLASS	SUBCLASS	FILING DATE IF APPROPRIATE
IK	5173612	12/22/92	IMAI et al.	250	505.1	
IK	4159437	06/26/79	SAHORES	313	59	
IK	4583243	04/15/86	DIEMER et al.	378	143	
IK	5258091	11/02/93	IMAI et al.	156	613	

FOREIGN PATENT DOCUMENTS

	DOCUMENT NUMBER	DATE	COUNTRY	CLASS	SUBCLASS	TRANSLATION YES	NO
IK	432568	06/19/91	E.P.O.	H01J	35/08		
IK	19544203	06/05/97	GERMANY				
IK	676772	101195	E.P.O.	G21K	1/10		

OTHER DOCUMENTS (Including Author, Title, Date, Pertinent Pages, Etc.)

EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP 609; Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.